PART SEVEN Background Context

Relationship to UK e-science directions and plans

The following quotation is the entire executive summary to "Developing The UK's E-Infrastructure For Science And Innovation", a Report of the UK OSI e-Infrastructure Working Group[5].

"The growth of the UK's knowledge-based economy depends significantly upon the continued support of the research community and in particular its activities to engage with industry and to apply its world-leading innovations to commercial use. A national e-infrastructure for research provides a vital foundation for the UK's science base, supporting not only rapidly advancing technological developments, but also the increasing possibilities for knowledge transfer and the creation of wealth.

With e-infrastructure requirements common across research disciplines, across Government departments and across sectors, such an e-infrastructure can further these and other key national objectives and indeed, through its support of world-leading research, help answer some of the 'grand challenges' facing the UK and the wider world, such as climate change, an ageing population and the combating of disease.

Technology is in large part driving globalisation – through increased specialisation, greater market integration and the removal of barriers, the sharing of knowledge and expertise and through its impact on worldwide economic growth. There is the danger, however, that in the new global market in which investment in technology and reward for innovation will increasingly determine a country's economic performance, the developing countries will 'leap frog' technological progress and overtake the world's more established economies.

Evidence already suggests that with massive investments being made in infrastructure development by rapidly industrialising countries such as China, India and South Korea, and by other more developed competitors, the UK is beginning to lag behind these worldwide advances, causing damage to its international competitiveness as well as its global leadership in research.

In March 2000, the EU Heads of States and Governments agreed to make the EU 'the most competitive and dynamic knowledge-driven economy by 2010'. While progress has been made in achieving the 'Lisbon goals', there is growing concern that the reform process is not going fast enough and that the ambitious targets will not be reached. Greater investment in the national e-infrastructure and the more coordinated approach to its development, detailed in this report, would therefore support not only the UK's vital national objectives but also its international commitments.

In the face of these worldwide developments, the UK needs a national e-infrastructure capable of meeting the needs of UK research and researchers in the digital age and the needs of the UK in a global market.

Elements of a UK e-infrastructure have grown over the years and indeed have helped secure the current standing of UK research, supporting vital developments in the pharmaceuticals, defence, information and media, financial services and other industries. However, with rapid advances in technology and the increasing dependence of the research community on data-intensive forms of research, such a position is not sustainable without a step-change in national provision and concerted action towards e-infrastructure development.

A national e-infrastructure needs: the means of producing, managing and preserving vast amounts of digital data; sophisticated means of accessing an ever-increasing range of electronic resources of all kinds; technologies and structures to support dynamic and virtual communities of researchers; unprecedented network, grid and computational capacity; and the necessary national services and systems to ensure safe and secure access to resources. We believe that these and other requirements presuppose not only a high level of integration and coordination, but also, in key areas, intervention at the policy level.

Underpinning all these requirements is the need for the adoption of agreed technical and other standards, for the appropriate training and skills to ensure that UK researchers from all disciplines can compete in a worldwide market, and for strong

[5] The OSI e-infrastructure Working Group was formed to explore the current provision of the UK's e-infrastructure and to help define its future development. Formed in response to the 'Science and Innovation Investment Framework 2004 – 2014', which was published by the Treasury, the DTI and the DfES in 2004, it is made up of senior representatives from the Research Councils, JISC (Joint Information Systems Committee),RIN (Research Information Network) and the British Library.

coordination between government, funders, research and development agencies, service providers, and universities and research centres.

The UK has a world-class research base, second only to the USA in global excellence as measured by citations. We believe that a national e-infrastructure built on the foundations outlined above and detailed in this report will be one that will enhance the global standing of UK research, maximise the immense potential of new technologies for knowledge transfer and help the UK achieve its wider social and economic goals."

The UK vision for a national e-infrastructure is described as follows:

"The UK's e-infrastructure should provide researchers with:

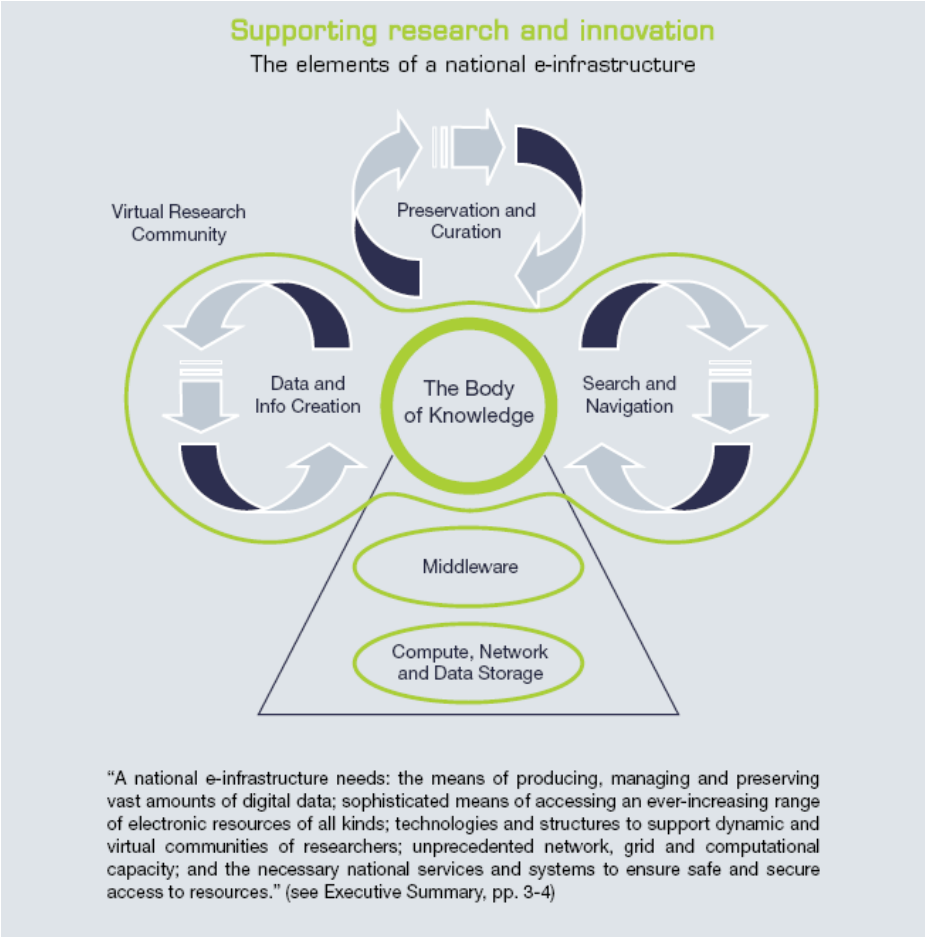
- Access to the systems, services, networks and resources that they need at the point that they need them
- Facilities to discover resources easily and use them appropriately
- Confidence in the integrity, authenticity and quality of the services and resources they use
- Assurance that their outputs will be accessible now and in the future
- A location-independent physical infrastructure for combining computation and information from multiple data sources
- Advanced technologies to support collaborative research
- The training and skills needed to exploit the services and resources available to them

The e-infrastructure should allow researchers to:

- Exploit the power of advanced information technologies and applications to continuously enhance the process of research itself
- Collaborate and communicate securely with others, across disciplines, institutions and sectors
- Maximise the potential of advanced technologies to support innovation and experimentation
- Share their research outputs with others and re-use them in the future
- Engage with industry in support of wider economic goals

The e-infrastructure must enable:

- The growth of knowledge transfer and the development of the commercial applications of research outputs
- Research funders to track the outputs from the research they fund
- The protection of individuals' privacy and work, within regulatory, legal and ethical constraints
- The protection of intellectual property and rights management
- The preservation of digital information output as a vital part of the nation's cultural and intellectual heritage"



In relation to this Investment Plan, it is obvious that the U.K. view is highly advanced in its focus around the use and re-use of content. The Platforms for Collaboration plan is more focussed on building the infrastructure, centres of expertise and day-to-day operational services that can provide a foundation for a more data and content inter-operation view.

We need to aim higher.

Alignment with CyberInfrastructure development by the US National Science Foundation

The latest draft report from the Office of CyberInfrastructure in the US National Science Foundation (NSF) provides the recommendations quoted below.

Each goal is followed by an indication of how the PfC investment relates to that goal.

The numbering is from the NSF Cyber-infrastructure report.

(a)	Provide communities addressing the most computationally challenging problems with access to a world-class high performance computing (HPC) environment.
PfC	Continue the investment in the APAC National Facility, acknowledge it is a specialist service and that its mission is to operate with an expert user orientation (HPC).

(b)	Broaden access to state-of-the-art computing resources, focusing especially on institutions with less capability and communities where computational science is an emerging activity.
PfC	Develop an integrated co-investment plan for regional compute and data support services (HPC, Data), and support a wider range of new e-Research users through a separate and strong focus on commodity tools and services (Tools).

(c)	Support the development and maintenance of robust systems software, programming tools, and applications needed to close the growing gap between peak performance and sustained performance on actual research codes, and to make the use of HPC systems, as well as novel architectures, easier and more accessible.
PfC	As a research activity this is outside of NCRIS scope, however NCRIS will require national pools of expertise and these can be tasked to provide support (where agreed) to research endeavours likely to lead to advanced application demonstrators (Support).

(d)	Support the continued development, expansion, hardening and maintenance of end-to-end software systems – user interfaces, workflow engines, science and engineering applications, data management, analysis and visualization tools, collaborative tools, and other software integrated into complete science and engineering systems via middleware – to bring the full power of a national cyberinfrastructure to communities of scientists and engineers.
PfC	Strengthen and focus the community support activities of the current APAC Grid program into user/discipline services activity using NCRIS capabilities as a prime motivator.

(e)	Support the development of the computing professionals, interdisciplinary teams, enabling policies and procedures, and new organizational structures such as virtual organizations, needed to achieve the scientific breakthroughs made possible by advanced CI, paying particular attention to the opportunities to broaden the participation of underrepresented groups.
PfC	Develop the AAF.

(f)	Support state-of-the-art innovation in data management and distribution systems, including digital libraries and educational environments that are expected to contribute to many of the scientific breakthroughs of the 21st century.
PfC	Initiate an Australian National Data Service to support these objectives.

(g)	Support the design and development of the CI needed to realize the full scientific potential of NSF's investments in tools and large facilities, from observatories and accelerators to sensor networks and remote observing systems.
PfC	Pursue campus infrastructure network harmonisation, accelerate extension of a national grid systems/middleware effort to additional parties.

(h)	Support the development and maintenance of the increasingly sophisticated applications needed to achieve the scientific goals of research and education communities.
PfC	Initiate a program focussed in the tools and discipline support area.

(i)	Invest in the high-risk/high-gain basic research in computer science, computing and storage devices, mathematical algorithms and the human/CI interfaces that are critical to powering the future exponential growth in all aspects of computing, from hardware speed, storage, connectivity and scientific productivity.
PfC	In general out of scope, however support can be provided to configure and operate infrastructure as part of research involving advanced demonstrations.

(j)	Provide a framework that will sustain reliable, stable resources and services while enabling the integration of new technologies and research developments with a minimum of disruption to users.
PfC	Resource a strategic oversight for the Platforms for Collaboration and other NCRIS informatics activities.

Alignment with the report of the e-Research Co-ordinating Committee

The executive summary of the report of the e-Research Co-ordinating Committee made the following key points, presented as excerpts from the text.

The e-Research Strategic Framework

"The report identifies the following key elements to be addressed by the e-Research strategic framework:

- The need for leadership and coordination;
- Fostering engagement and consensus building;
- Research, development and deployment of ICT solutions for e-Research;
- Skills acquisition;
- Support for researchers through a national e-Research Centre;
- Access, authentication and authorisation;
- Support for the e-Research fabric;
- Data management and accessible databases; and
- Coordination of effort."

A vision for e-Research in Australia

"The report identifies the following vision for e-Research:

> *Australian researchers will enhance their contribution to world-class research endeavours and outcomes, through the use of advanced and innovative information and communications technologies.*

The vision encourages researchers to participate in the transformation process being enabled by ICT, as it offers the power to improve existing research, to work collaboratively and globally, and to undertake research on a scope previously unattainable."

The need for leadership and coordination

"Progressing the e-Research agenda is as much about people as it is about technology. e-Research challenges existing research practices and cultures. It is a change agent and, as such, there is a need for strong leadership to articulate the vision and engage key players in taking the strategy forward in a coordinated manner.

Overseas experience, particularly in the UK, strongly suggests that success in engaging the research community in e-Research is associated with the appointment of a 'champion', a well-respected member of the community, recognised by government, the research sector and business as the visible face of e-Research."

PfC: The NRICC would provide a suitable forum within which one or more such 'envoys' might be appointed, supporting an association with broad discipline interests.

Building on the current research base

"The delivery of operational services in response to the needs of researchers is critical to the uptake of e-Research. The Australian Government has invested in a range of highly innovative projects conducted under the auspices of the Australian Research Information Infrastructure Committee (ARIIC), the Advanced Networks Programme (ANP), the Australian Research Council (ARC), the National Health and Medical Research Council (NH&MRC), the CSIRO and other agencies and institutes. The outcomes of these projects are informing the development of operational services. While the development of operational services is not confined to Australia, and we should adopt and adapt as appropriate, further research and development to support e-Research capabilities is essential. In particular, the participation in international standards setting based on Australian research and development should be encouraged, so there will be a return on investment in this area."

PfC: The Interoperation and Collaboration Infrastructure provides the cohesive support of fully operational services and the Application and Discipline Services is a program which directly addresses this requirement.

Skills acquisition

Many of the technologies which support e-Research capabilities are at the cutting edge of developments world wide. While Australia has a number of world-class leaders in some of these technologies, there is a system-wide lack of skills to support the rapid take up of e-Research capabilities. The report identifies a number of skills groups that need to be established or strengthened, including:

- Practical skills for researchers who wish to implement e-Research applications;

- Skilled professionals who can operate across research domains to assist researchers to implement e-Research applications; and
- Experts in ICT and information management who are capable of undertaking research and development of new e-Research platforms and applications.

The report proposes that these skills deficiencies be addressed by a number of complementary strategies."

PfC: This is mostly unaddressed, other than through incidental development arising through project work.

Skills transfer and support for researchers through an e-Research Centre

"In the UK, the success of the government funded e-Science initiative was due in large part to the establishment of several e-Science centres which provided a focal point for research, development, support and outreach into e-Science.

Similarly, this report recommends the establishment of a national e-Research Centre comprised of several nodes established in regions of research intensity. Their primary role would be to act as change agents locally and nationally to embed e-Research methodologies in research practices. The nodes would provide outreach programmes and support services for researchers and serve a critical role in skills development, skills transfer and the development and deployment of e-Research applications."

PfC: The investments will create a new centre of expertise in data management skills, enhance grid operational skills, sustain HPC skills and develop over time a broadly based skill set related to e-Research solution development.

Access for Researchers

"A key enabler for e-Research in Australia is to give researchers seamless access to resources, including each other. The resources are distributed in various areas of Australia and overseas. These resources include:

- Digital data repositories;
- Scientific facilities, instruments and sensors;
- Computational facilities; and
- High-speed telecommunications networks.

The Committee has identified the need to put in place a national, robust identity provision solution that will allow researchers' identity to be authenticated, and their access authorised, to distributed resources via a single sign-on system."

PfC: The existing APAC grid will be challenged to develop a more sophisticated standardisation of its processes and services, and to outreach to similarly connect resources beyond the its participants.

The Australian Access Federation will be established to provide the required identity solution.

Support for the research fabric

"The 'e-Research fabric' refers to the physical resources that link, or are linked to enable, e-Research activities. They include broadband networks, middleware services, computing capability, scientific instruments, and digital data repositories. Linking the physical resources can significantly add capability as well as capacity to the e-Research infrastructure."

"… there will be an ongoing need to extend broadband capability to more remote institutions in the network and to other key sources of data and resources, including research agencies, cultural institutions and strategically important international partners.

The availability of high performance computing capability is critical to support a number of e-Research applications. As a result of substantial Government investments in recent years, the Australian Partnership for Advanced Computing (APAC), a number of universities and publicly funded research agencies provide high performance computing facilities in various parts of Australia. Many of these computing facilities are networked and therefore can provide distributed computing capability. In terms of implementing the e-Research agenda, it is important that as many such facilities as possible be available to service researchers' increasingly advanced computing needs."

"… The full utilisation of advanced ICT infrastructure is increasingly dependent on computer software, termed middleware, that links the ICT resources that users need. Middleware provides the common set of services and tools that allows researchers and applications to treat the data repositories, computing, and other disparate resources as if they were one large virtual facility.

While there has been considerable progress in middleware development and deployment both within Australia and overseas, the Report recommends that

arrangements should be put in place to reduce duplication of effort and deliver widespread efficiencies. This could be achieved through the adoption of a common middleware strategy developed in the context of Australian and international standards."

PfC: The operational grid will be challenged to extended to all significant compute, data, instrument and sensor resources as are nationally significant.

Because funding is limited, middleware development will be limited to components required by application services in NCRIS capabilities and other nationally important disciplines and specifically related to components expected to migrate into operational services in the short term.

A reduced set of core middleware will be identified and supported as core common services.

Managing Data

"Managing data effectively is essential to support the full cycle of research endeavour, from research concept formulation and scoping to the research activity itself, to dissemination of the results of research.

The Committee identified the data management needs of researchers as being:

- data collection and generation;
- data storage and the physical management of stored data;
- the evolution of standards to enable data to be used and interpreted;
- access to data; and
- long term archival and preservation of data and policy for retaining and discarding of data.

Research domains globally are generating unprecedented quantities of data and the issue of data management is increasingly a critical one. There is need to balance the likely accessibility needs of researchers to data against the likely costs to the research sector and the wider community of long term data retention.

The report recommends that the Government convenes a working group to develop an Australian Research Data Strategy. Such a strategy must be considered in the international research context, given that Australia's research sector will need to align with prevalent international data management standards in order to engage fully with overseas researchers into the future."

PfC: The NRICC provides a forum in which and Australian Data Strategy can be developed.

Because funding is limited, the primary focus of the investments in data management is towards supporting researchers in data collection and generation, and developing services that assist access to data. Some support is provided to storage and retention for critical collections (such as irrecoverable time-based studies) and not otherwise supported.

The problem of the explosion in data retention is not directly addressed, however a co-operative framework of regional data retention services that could be urgently expanded, will be established.

Coordination, Oversight and Resources

"The report recommends that an e-Research Committee be established to replace the existing Coordinating Committee in order to implement the e-Research Strategic Framework over a period of five years. The new Committee would provide the strategic direction, drive and engagement and coordination of effort of research groups involved in e-Research. It would also take account of existing Systemic Infrastructure Initiative (SII) advisory structures and develop a close working relationship with the NCRIS Committee and its facilitators."

And "… The Committee has estimated that the cost of implementing the e-Research Strategic Framework to be in the order of $25 million per year, over five years. Given the Australian Government's $8.3 billion investment in research and research infrastructure over 2001-02 to 2010-11, this relatively modest investment in e-Research is seen as prudent and likely to improve the return significantly on the Government's substantial investment in research and research infrastructure."

PfC: NRICC would satisfy this requirement.

The requirement strengthens the case of a government operated lead activity as opposed to an independent incorporated entity, which by definition must have less attachment to government policy and direction setting.

As the eRCC proposal was largely concerned with expertise development and as PfC will spend at most $20M pa including hard infrastructure and service implementation, most of the needs can only be assessed as partly met and some must be considered unmet. There is at least a $15M pa shortfall in the areas identified for support by the eRCC compared to the contribution PfC will make to those areas.

Input from the APAC Review

The Australian Partnership for Advanced Computing has been a pivotal developer and provider of HPC services in Australia for six years. For the last three years it has also developed a nationally co-ordinated approach to grid middleware and application services; focussing into selected areas, those being: astronomy, bioinformatics, chemistry, earth system science, geosciences and high energy physics.

Consequently, APAC can be seen to have identified e-Research needs early and to have provided essential leadership into the e-Research space.

However, its primary competencies lie in the areas of HPC and Grid, and hence the underlying basis from which it proceeds and the services it supports, necessarily target expert users and the expert builder-users of cyber-infrastructure.

Such services, of course, need to continue and the Investment Plan provides for that.

The plan also proposes two additional functions, one focussed against the issues identified in Data and another focussed against the issues identified in Tools.

Apart from broadening the range of competencies involved, these new activities support missions intentionally attuned to new e-Researchers and hence engage different communities and require different competencies and management.

Other contextual changes envisaged in the Investment Plan include:

- A move to an expert governing board for the managing entity
- The membership of the managing entity (whom appoint the governing board) to be representative of the research community, institutional and government beneficiaries and co-investors, rather than limited to recipients of funding
- Development of a set of thematic program agreements allowing selective participation, in preference to an all-encompassing joint venture
- The addition of a general data support investment addressing the needs of the research data community at a national level, as distinct from the more narrowly defined interests of “data-computationalists”
- The addition of a tools and discipline support program targeting the development and operation of generic services for e-Researchers, building on a layer of services aimed at experts and other infrastructure builders
- A focussing on the other NCRIS capability areas as a priority in the expert and user-builder focussed activities

Many of these adjustments were not evident in the review, such as the requirement for support of naïve users and the overall requirement in data management. The full set of recommendations of the APAC Review appear in Appendix X?. They have influenced, and been accommodated in, the investment areas to which they apply.

Assessment of strategic options for Australia to respond to these needs through investments in systemic infrastructure, skills and services.

Any option for responding to these needs should recognise that the capability (which includes the systemic infrastructure, skills and services) exists at three levels (a resource triangle):

(i) within particular research institutions and facilities;
(ii) within formalised groupings which can be based around geography or communities of practice; and
(iii) within national organisations that can provide the appropriate leadership to ensure that the national needs are met and that Australia is able to continue to respond to global research challenges.

While investment can occur at all three present levels, the best outcome is achieved when these investments are coordinated and the capabilities within these levels are available.

However, there may not be one single investment strategy to best meet the different needs identified in TOR 4. This has been recognised in the development of NCRIS where Capability 5.16 "Platforms for Collaboration" is intended to provide infrastructure to support the common needs, such as networking, data storage, transfer, analysis and accessibility. Depending on the individual capabilities, some of these needs may be best served by investment at a research facility (eg localised data storage and compute facilities) while others such as peak computing facilities may be best served by investment in a centralised organisation.

Similarly, there is a diversity of imperatives that drive the investment. The drive for research excellence will lead to investment in greater capability in peak facilities while the enabling of collaboration will drive investment in grid technology and capacity.

Comments on transitions in service level appropriate to Australian infrastructure services

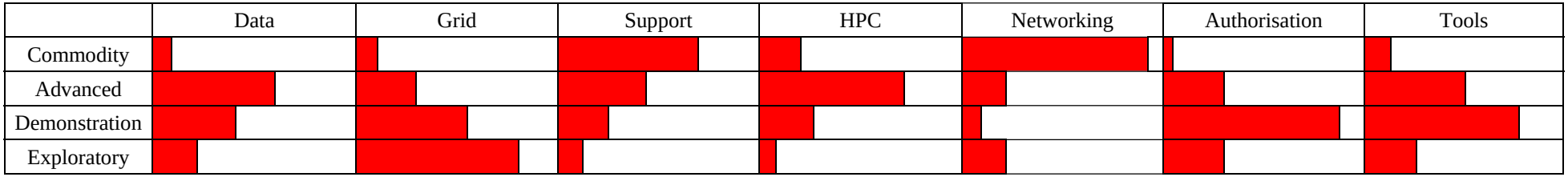
e-Research will need to become an increasingly normal part of research activity if the vision is to be realised, and Platforms for Collaboration will need to invest in ways that develop the appropriate emergent capabilities from the results of many investments by many participants.

Hence the investment plan sets out to act on the difference between the current state and the proposed future state for each of these emergent capabilities. It does that by ensuring that necessary and appropriate e-Research services exist and are universally accessible.

Because broad adoption always depends on commoditisation, the plan naturally considers where and how 'commoditised'[6] e-Research services can be developed. It is important to recall that leading edge e-Research cannot be commoditised by definition, however, it is also the case that it should build on commodity services where ever possible. So a better understanding around commodity services needs to be developed.

To do that, it is useful to consider services in several classes: Commodity/generic, Advanced/specialised, Demonstration/prototype, Exploratory/research. The services in these classes could be expected to require increasing levels of user expertise for their effective deployment, have decreasing quality of service levels and perhaps decreasing availability, and involve different partners and arrangements for co-investment.

Considering the areas above, and limiting a view to e-Research services, the overarching investment goals can be established by examining a representative pattern of current activity; which approximately might be as follows.



Broad e-Research adoption depends on some of these patterns being changed.

Data	At present, only some enterprise research data and some community reference collections have a permanent home. Many disciplines are creating purpose built data retention and access services, operated on a co-operative basis by research groups. Most leading edge analysis is bespoke and user based, though the provision of 3rd party analysis tools and methodologies is increasing (and prevalent where applicable on the desktop in disciplines such as engineering).
Delta	Simple retention and curation tools need to be broadly available, standard practice needs to be promulgated and understood and help made readily available. The development and support of relevant extraction, reduction and analysis functions as part of each data service is an essential step required in the transition to a future of information services rather than data services.
Implications	Commodity hosting of these services is needed, for data already managed and more importantly for data yet to be managed, further demonstration activities will also be required

[6] Where commoditised in this context means: able to be used with generally available discipline knowledge and without expert or deep service specific knowledge or sophisticated technological understanding.

Grid	At present, nearly all grid services are provided in advanced or demonstration modes and users are regularly exposed to the details of the technologies. Some leading discipline specific examples are in daily operation, but not yet in what could be considered a commodity user form.
Delta	Unfortunately little change in this state is expected over the next 5 years as the technology is under evolutionary development. This is a major constraint on the investment plan.
Implications	The majority of investment in the grid area will need to target expert users, advanced research communities and can only realistically support the "builders" of user facing services in the short term.

Support	It is important to note that the majority of staff providing IT support to researchers operate within well managed IT support services, but that the technologies that Platforms for Collaboration might deploy, are not currently within the scope of those services. Consequently, much of the support activity relevant to Platforms for Collaboration operates in services aimed at expert users, or as an adjunct to research teams and communities, and is either outside of the rigour of commodity service provision or difficult to access as an in-expert user. Overall, there is a significant shortfall in relevant and available expertise.
Delta	Centres of expertise have been built in areas such as HPC and networking, and to an extent in data (where investments have been made). Stronger investment is required in relevant expert groups and strategies are needed that can migrate that expertise into providers focussed on broad support and service delivery.
Implications	National co-operative provisioning and use of platform technology expertise is crucial. Support functions will be best placed with their related services and providers, rather than in an independent activity, in order to better cope with the steep learning curves required. Support will only be able to be treated more systematically in areas where stability can be achieved in the technology platforms and the tools adopted by the various disciplines to support their e-Research activities.

HPC	A peak capability exists, shoulder capabilities are growing, and many independent other resources exist. System wide brokerage of resource use and work migration and co-ordination remain difficult.
Delta	Peak computing services will remain advanced services for the foreseeable future and are not amenable to commoditisation. The Peak facility will always need to manage itself towards a limited market. The overall investment in HPC needs to better meet the needs of a broader user base by provisioning compute support for tools and analysis services. Platforms for Collaboration needs a coherent compute fabric so that successful tools and services can migrate or be replicated as part of supporting broader e-Research adoption.
Implications	The peak capability is well understood from a mission perspective, along with its related processes and investment requirements, and should be protected from demands for generic or commodity services. An investment outside of peak capability is needed to meet the need for a generic computing environment for commodity tools and analysis services.

Networking	Network technology is very well developed, so that 'commodity' services with high levels of service are the norm, and indeed provided. In the case of the AREN, many non-academic researchers are not connected, tolls exist in institutional frameworks, and high bandwidth transfers remain difficult. Overall research traffic volumes do not yet justify the network investment, a problem which needs to be addressed by encouraging research data interchange.
Delta	Effective access must be provided to researchers outside of the AARNet members. Institutional network infrastructures and policies need to be harmonised with the vision for the AREN. Some increase in advanced and demonstration quality activities is needed to develop the future research support focus of the network.
Implications	An expert group should be established to assist the harmonisation of campus infrastructures, an investment in demonstrators that lead to higher use is crucial, an outreach network (with possibly different QoS) should be established to open AREN to all appropriate Australian researchers (for on-net traffic).

Authorisation	Inter-institutional (and hence regional, national and international) authorisation services with reasonable usability characteristics, are only just now being constructed anywhere in the world.
Delta	A shift to the provision of a set of simple core services in a commodity service mode is crucial, further demonstration activities will also be required as this area is expected to evolve rapidly. Modification of applications and e-Research support tools will be needed to interface with the authorisation services, if uptake is to occur.
Implications	The foundation of the AAF as a core e-Research service provider is essential for broader e-Research adoption. On-going investments will be needed to assist that process, which should focus on developing a centre of expertise around the service, providing exemplar collaboration tools and services, and an outreach activity aimed at adapting discipline specific e-Research tools to interface with the service.

Tools	At present, analysis activities often require a researcher to understand the tools they use, the tools others use, the data sources, the specific compute engines as well as many of the intervening systems. Many disciplines have developed some common methods and tools, often on a best effort basis. Little co-adoption across disciplines is evident, with a notable exception in the spatial data area. Standards-based web and messaging solutions appear to meet some of the research collaboration needs, and can be expected to provide a variety of highly commoditised collaboration tools.
Delta	The fundamental resource in this area is human, and its availability is limited. Hence some choices in middleware and tool components needs to be made if more commodity like services are to be supplied to a larger set of e-Researchers. This should be through an explicit investment in building expertise, support and the provision of capacity around nominated components. Platforms for Collaboration should focus on functionality and tools for the builders of cyber-infrastructure and work with other NCRIS investments to identify and support functionality and tools for users. A nationally coherent computing/data management fabric that could host application selected tools and components would significantly increase their adoption.
Implications	Investment is needed to establish a national compute/data fabric, which would need to include existing regional providers and major research institutions. Strategies for effectively deploying and rapidly developing expertise levels right across e-Research interests is a crucial requirement of the investment plan.